the Mecheleciv

THE GEORGE WASHINGTON UNIVERSITY ~ SCHOOL OF ENGINEERING ~

VOL. 19 MAY 1961 NO. 6

THE GEORGE WASHINGTON UNIVERSITY MAY 1961

FACTS ABOUT AIR FORCE OFFICER TRAINING FOR ENGINEERS

Who is eligible?

College graduates, with a degree from an accredited college or university, who are U.S. citizens 20½ to 27½ at time of application. Male applicants may be married or unmarried; female applicants must be single and have no dependents. Applicants must complete written and physical examinations for commissioning.

What kinds of engineers are needed most?

Aeronautical, electrical, mechanical, civil, architectural, industrial. (Also graduates with any degree who majored in nuclear physics, engineering physics or meteorology.)

What is Air Force Officer Training School?

A precommission training course of 3 months' duration at Lackland Air Force Base, Texas. Officer trainees upon graduation receive a commission as second lieutenant. They are then assigned directly to duty or additional training.

Does the Air Force offer career opportunities?

Yes. Technically trained officers have a particularly bright career outlook. They have good opportunities for graduate study.

How can further information be obtained?

Write to OTS Information, Box 7608, Washington 4, D.C., or inquire at any Air Force Recruiting Office, listed in the telephone directory under "U.S. Government—Air Force."

Civilian Career Opportunities

The Air Force also offers challenging jobs for engineers as civilians. Write to Directorate of Civilian Personnel, Hq. Air Force Systems Command, Andrews Air Force Base, Washington 25, D. C., concerning opportunities for individuals with degrees in aeronautical, electrical, electronic, and mechanical engineering. Write to Directorate of Civilian Personnel, Hq. Air Force Logistics Command, Wright-Patterson Air Force Base, Ohio, concerning opportunities for individuals with degrees in industrial engineering.

President John F. Kennedy and newly inaugurated University President Thomas H. Carrol, wearing University Seal, participate in the inauguration ceremonies May 3, in Lisner Yard. President Kennedy received an honorary Doctor of Laws degree in the ceremonies. Dean of Faculties John Latimer stands between the two presidents.

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ARTICLES

DEPARTMENTS

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EXTERNAL FORCES

Educational institutions, educators, and scholars are presently under many pressures that will tend to seriously suppress fulfilling the real needs of an engineering education. These pressures are not of single origin. We are certainly aware that industry has an attractiveness no longer afforded by the educational institution. It goes without saying, money will not buy the services of dedicated people in the professiorial ranks. Another aspect acutely familiar to the engineer is that in four short years we are unable to get both a "well-rounded liberal education," or command an all-encompassing code of ethics. Still another more recent criticism, and probably more unjust than any, is that American technology is no longer first in the world's eye.

There are many reports that point to the crisis which education must face up to in this decade. "The Impending Tidal Wave of Students" was published in 1954 by the American Association of Collegiate Registrars and Admissions Officers; "A Call for Action" to meet the increase in college and university enrollment was issued by the American Council of Education; "Teachers Supply and Demand in Colleges and Universities" revealed a study conducted by the Research Division of the National Education Association; "Engineering Enrollment and Faculty Requirements, 1957-67" and "Report of an Ad Hoc Committee on Loll of Faculty to Industry" were reported by the American Association for Engineering Education.

You can bet that at the next session of Congress all eligible recipients of government financial aid to education will be standing in line with palms up. The time is ripe, particularly with regard to government legislation to aid technological programs and facilities. Presently there are two factions of an aid bill. The first limits aid to "expansion of new facilities," while the other places no restrictions, presuming that salaries etc., could be paid by this financial aid. The first dictates the size and shape of the system. The other, while it may offer a freedom route from some educational crisis, could be threatened by the hands of graft.

Then, there is the threat of standardization and loss of incentive for individual effort on two fronts. First there is the threat of mass teaching techniques as a result of a disportionate growth between college age population and facilities. The inevitable tasks of the educator can never be accomplished by a punch-card student-teacher relationship. Teaching is a meritorious service only when personal contact with students reveals the glory of creative minds. (This aspect was the subject of the October editorial, MECHELECIV.)

Secondly, every state requires that a candidate for a Professional Engineering License be a graduate of an accredited school. There is only one accrediting agency that has accomplished great things in the advancement of educational and professional standards. They have accomplished this by standardizing standards. We have all the provisions built in our system to standardize what is taught and how it is taught. Some educators argue that engineers are trained mathematicians and physicists capable of transient analysis, stress analysis and certain other mathematical implications with no pretense of a capability for actual design. Try to standardize the mind and its methods. If there ever was incentive for individual effort it can soon die in a system such as this.

WHAT IS ECONOMICS?

by Franklin P. Hall

A degree of mystery surrounds the popular conception of economics. This is unnecessary. Students choosing economics as a course of study should know its content sufficiently to be assured it contains something they want. Yet, so ill-understood is the term that a lecture scarcely suffices to orient the MEA student to its content. Perhaps economists are at fault here. Those who know economics say too little about it. Perhaps those who do not know economics say too much. Probably confusion is unavoidable, for so much is deemed to be economics that rigid selection of material for a one-semester course is mandatory. Naturally, the meaning of economics dictates the subject-matter of a course of study in it. Yet so much of the material that is our daily lives has been denominated economics that selection is most essential. The need is the greater, therefor, that the student begin with a clear idea of the scope of economics and of its importance. These facts provide the elements of definition of economics. What are the earmarks of the material that qualifies for inclusion in such a course of study?

To begin with a broad, inclusive view, economics relates to the counting of costs and returns. Cost are the labor, the discomfort, as well as the money expense, of doing a given thing; a project. Returns are the revenues or satisfactions from prosecuting that project or doing that single act. Thus economics deals with the pros and cons of human activity — a very widespread subject. It could, in a simple and familiar context, involve a debate as to the advantages, versus disadvantages, of one's activities of but a given day or less. Again, in terms involving many people for a long time, it could mean the same counting of advantage or disadvantage of a multi-million dollar investment in a huge hydro-electric project. And less tangibly perhaps, it may be the like aspects of a given legislative policy affecting the entire nation.

The essential subject matter of economics as being a process for determining advantage and disadvantage — "to do or not to do;" should be clear from these illustrations. It is a matter of ways and means. Things are done with means; with resources. These means are employed in ways intended to overcome scarcity, perhaps make available a product that did not previously exist; to process raw materials so that finished goods are obtained. In this meaning, economics consists of taking thought as to the best ways of using the most appropriate means to achieve desired results. Engineers find this interpretation of economics readily understandable. They are accustomed to measuring and estimating the inputs required for a given projected experiment or piece of work as against the benefits to be gained by the doing of it.

Of course, the benefits flowing from a project should be greater than the energy requirements or the funds needed; greater, in short, than the cost of the resources that must be spent or expended to do the job and get the results. In fact, the same is true of every specific use of resources, whatever they be. One can say, further, that of several proposals to use given resources for given purposes the one chosen should promise the greatest net return of benefits in excess of costs.

This may seem to be a matter of slight importance in personal or individual terms. If one fails to-day to secure from his activities as much satisfaction as he expected to do, not much is lost, and there is another day coming. But if the hydro-electric site in question is not used, there is a loss of power and other benefits that would otherwise have been generated and provided. If the project as built is not the best use that could be made of the site, there is a longer-term failure of potential. Perhaps costs higher than need be, or benefits less than feasible are experienced for many years. Planning for careful selection of alternatives is advisable, being as important as the object in view. Let us hasten to add that as individuals we cannot condone the loss even of one day of time and effort from the life of

—Continued on next page

Dr. Hall is presently a financial economist for the Federal Power Commission Finance Division and Professorial Lecturer in Economic Analysis in the graduate Engineering Administration program at George Washington. He received his B.A. in Economics from U. of Oregon in 1929, an M.A. in Economic Theory in 1931, and Ph.D in Public Finance in 1945, both from U. of Wisconsin.

In addition to many teaching tasks as a graduate student Dr. Hall has taught at colleges and universities throughout the country. He has held responsible positions as an economist in the areas of agriculture, industry, foreign and domestic trade, public finance, tax research, and vital statistics. His several publications include articles on business cycles, employment, foreign trade, economic analysis for engineering planning, and managerial economics.

This article was written as an introduction to materials for the course "Economic Analysis for Engineering Planning" taught in the graduate curriculum at George Washington.

any one. Time, when past, is gone forever. In a real sense it does not recur. Resources remain, perhaps. But time, which is itself a resource, does not tarry. A steel strike, idling thousands for months, reduces industrial production, and the reduced output is "lost" almost as if the man-days, accumulated into man-lives, had been removed by the death of an equivalent number of workers.

In summary, economics becomes the means of making the best choices of human activity, the best use of man's resources, be they such natural resources as minerals and energy potentials or the human resources of labor and organization. Economics generally confines itself to material concerns. Yet fundamentally, all inputs are forms and quantities of human effort. In this form they are intangible and non-material. Similarly, all benefits are human satisfactions, which are equally intangible. So, while economics hopes that the philosopher or sociologist will concern himself with inputs and outputs in their non-material, human form, it offers to assist scientists in discovering the quantities if not the qualities of needed efforts and derived satisfactions by relating them to the more material objects and forms in which they are embodied or by means of which they become involved in economic study.

But what are some of the matters economics particularly involves? The word economics derives from roots that mean household management. When first applied in early modern Europe, the term was applied to counselors who advised the king as to the management of the kingdom. Hence the British term "Political Economy" that is still widely used and understood. This is the public aspect of the subject: managerial problems connected with governmental operations, which is public administration. But economics embraces also questions of financing of public activities and the execution and development of legislative programs and proposals. The highest use for the purest of economic theory is in matters of broad public policy.

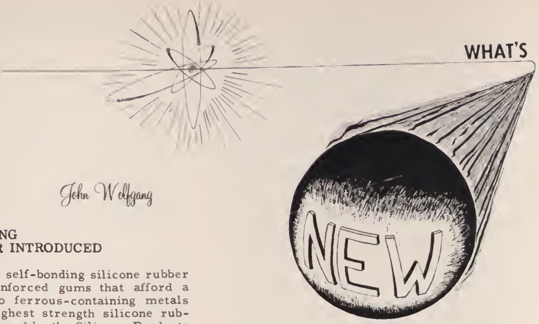
But is there not an economics that has little to do with politics, government, or what may realistically be called the public sector of our community life? Is there not a private economics? Indeed there is! It follows from what has already been said. In the private sector may be found a variety of group economics such as business economics as well as personal economics, firm economics (firms are business organization units), family economics and home economics — the economics of familial organizations, or institutions. There appears, therefor, to be an economics of just about everything. Recall that we said economics is related to human activities, and it follows that all human organization has an economics, its economic aspect.

Now we can define economics as the social science of man's wealth — getting and wealth-using. That is, economics is the science of wealth. By "science" is meant knowledge and its organization as generalizations concerning natural and human concerns and phenomena. Consequently, economics is applied to understanding the production, exchange, and distribution of goods (things that have value, i.e., wealth) and with the distribution throughout society of the total wealth that has been produced. So economics gets into problems of welfare and social justice, but it prefers to stay nearer to its material concerns.

All this is understandable to engineers especially because engineering problems deal with energy contributions to material situations out of which comes work; useful accomplishment achieved with the minimum of effort that is essential to the result.

To many, however, this becomes economics only after dollar amounts, as prices, are substituted for the energy-quantity inputs and work-outputs that are concerned. This is true in a somewhat superficial sense. In the sense, that is, that economics deals with prices and money quantities. Economics does this chiefly for convenience. Money units are used as measurement units of inputs and of outputs and of wealth. Engineering management needs to answer the question: What money costs will be involved in doing given work — and what is the money value of what the work accomplishes? Is it worth the cost? Had we better do something else with our facilities and equipment? These are eminently practical questions, dealing with concrete realities. It is perhaps not easy to sense the connection between them and such great issues as whether federal public works should be prosecuted at all or at what times. Yet the essentials are at least similar enough that the analogy provides an avenue of approach to the profundities of economic analysis. One may say that work-doing and wealth production require energy and material inputs; that the consequences are work done and achievement. In a world of commerce, of commercial economics, the use of resources requires their purchase at market prices; their values being measured in money terms. They then become money costs to our work-project as well as being energy and material inputs. The products are either saleable or assessable in money-equivalent terms be they material or intangible. All required is that there be a market for them presently or at some future time. History, if not contemporary events, may tell us the value in terms we need to know. Estimates, based on sensible hypotheses, may help to fill gaps at least tentatively.

Price and valuation are the heart of economics. But the concept of inputs and outputs that account for costs and incomes and for results as motivating forces is the foundation for analysis. What remains unmentioned is the concept of capital, its formation out of saved funds its devotion to investment through the purchase of durable productive equipment, the real capital of economics, the assets of the accountant. This and the function of money, the lifeblood of an operating, materialistic, going economy. These things are the means of Economic Analysis.



Edited by

John Wolfgang

NEW SELF-BONDING SILICONE RUBBER INTRODUCED

A new family of self-bonding silicone rubber compounds and reinforced gums that afford a primerless bond to ferrous-containing metals stronger than the highest strength silicone rubber have been developed by the Silicone Products Department of General Electric, Waterford, New York.

Designated SE-5504U, the initially-available grade is a high strength, extreme low temperature compound similar to GE's standard SE-555. It is expected that this material will be of use to mechanical rubber fabricators in broad line processing and to specialty manufacturers for shock mounts, rubber rolls, oil seals and a variety of other products where high-strength, trouble-free bonds are desired.

BOND STRONGER THAN RUBBER – New self-bonding General Electric silicone rubber, SE-5504U, provides a primerless bond to ferrous metals stronger than the highest strength silicone rubber. Bond on surfaces above withstood stresses greater than the strength of the elastomer itself. Rubber stretched to approximately five times its original size under direct pulling stress and slowly ruptured while bond remained intact as shown.

G-E reports the new self-bonding grades will cut the number of steps involved in the silicone rubber bonding process in half.

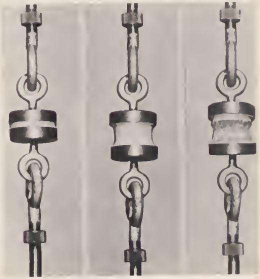
SE-5504U is a gray compound with a typical physical profile after cure of 25 hours/350°F as follows:

Tensile Strength	-	1500 psi
Tear	-	200 psi
Elongation	-	550%
Durometer	-	50
Compression set 22/300°F	-	45%

Excellent bonds have already been established to steel, chrome steel and stainless steel, and G-E reports that other metals are being investigated at the present time.

Unlike techniques using a primer, where the primer achieves the chemical interaction between the elastomer and the surface to which it is to be bonded, the new self-bonding grade of silicone rubber establishes a bond through a direct reaction with the metal surface. The chemical bond of SE-5504U is much stronger than a physical bond and offers better heat and solvent resistance.

Metal surfaces should be of a ferrous-type. Nickel, chrome, iron, steel, stainless steel, or



SELF-BONDING SILICONE RUBBER – New self-bonding General Electric silicone rubber, SE-5504U, bonds to ferrous metals without priming with an adhesive force stronger than the highest strength silicone rubber. Direct pulling tests, shown above, failed to destroy the bond at stresses exceeding the the strength of the rubber itself. Left to right, shows bond at three points of increasing stress in tests. When rubber had stretched to approximately five times its original size (right), it slowly ruptured but the bond remained intact.

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MICROELECTRONICS

by James E. Jennings, EE '61

INTRODUCTION

The term microelectronics is applied here to solid state devices which in themselves perform electronic functions such as amplification, oscillation, and telemetering, as compared to the macroelectronic systems of today which require the assembly of many components to perform the same function.

Microelectronic systems are being developed as a means to reduce the size and weight of present day electronic equipment and at the same time increase their reliability. Solid state devices are inherently smaller and lighter than present components and the vast amount of research in this field leads naturally to its use. The size and weight reduction obtained through the use of microelectronic systems will allow us to provide the increasingly complex electronic equipment required for our aircraft, missile, and satellite systems. We will be able to increase our equipment capabilities per unit weight and per unit volume.

Reliability is extremely important today especially in the case of one-shot systems such as missiles and satellites which must be successful the first time they are tried. The increased complexity of these systems decreases their reliability. That is, the probability of system failure increases as the number of components and solder joints increases.

Quality control alone is not the answer. Microelectronic devices (functional blocks) because of their very nature will vastly decrease the number of components and solder joints required for a given system and thus increase system reliability. Their decreased size as compared to today's components will provide room for the use of redundant networks and the necessary logic elements to facilitate their use. This will further increase system reliability.

Eventually microelectronic devices will cost less than their present day counterparts. They require less processing and that which is involved readily adapts itself to automation. One set of tests is required to completely check out a whole assembly. Solid state devices also require less power for their operation than standard components and will thus reduce the amount of equipment necessary to provide that power. This will further increase the space available for electronic equipment.

Industry today recognizes the need for microelectronics. Many firms are now in the process of developing microelectronic systems and at present their total investment is conservatively estimated at upward of 100 million dollars.

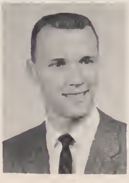
DEVELOPMENT OF A MICROELECTRONIC FUNCTIONAL BLOCK

Let us now consider the development of a microelectronic functional block. We want to build the entire circuit on a single semiconducter wafer. We also want to use the conventional transistor processing techniques of oxide masking, diffusion, metal deposition, alloying, electron-beam machining, and surface shaping, if possible, because these techniques are already in use. Once the network to be produced as a functional block is determined, the semiconductor techniques engineer compares the circuit elements with the conduction paths within the semiconductor material. He then transforms the original schematic into a three dimensional one in order to visualize the conductance paths and the geometry of the final device.

Construction of the functional block begins with the selection of a single crystal of a semiconductor material. Silicon is normally chosen because it has a higher intrinsic resistivity and better surface stabilization than germanium. The crystal is then sliced, lapped and polished, a step that will be eliminated if the dendritic process (making long crystal ribbons) can be made economically practical.

The silicon wafer is used to form all of the resistors, the transistor collector regions and the diode cathode areas. It is then coated with silicon oxide and a layer of material known as photoresist. Previously the engineer has determined the areas which are to form the diodes, capacitors and transistors. A photoetching process is used to expose the silicon oxide over these areas and then hydrofluoric acid is used to remove the exposed silicon oxide (see figure 1).

A process of diffusion is then used to diffuse the opposite type semiconductor material into the selected areas of the silicon wafer. The p-n junctions thus formed can be used in several ways. As they are they form either p-n junction diodes or transistor base regions. If back bias is applied to them they form distributed capacitance capacitors. The capacitance of which



Jim Jennings, a 24 year old married senior in Electrical Engineering, started at G.W. in September of 1954. He stayed here for two years and then went to radar school at Ft. Bliss, Texas. He returned to G.W. in 1958 and plans to graduate this June.

Jim became interested in the field of microelectronics last summer and decided that this would make a good subject for his EE proseminar paper. This article is a condensation of his paper.

He is moving to Connecticut soon after graduation to take a job with the Norden Division of the United Aircraft Corporation. He will be assigned to their applied physics laboratory where he will work in the field of microelectronics. He hopes to do graduate work at Yale University.

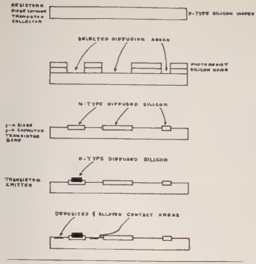


FIGURE 1

A general microelectronic network

depends on the area of the junction. Values up to 200,000 picafarads per sq. cm. have been obtained.

The rest of the photoresist and silicon oxide is then removed by the process used on the selected areas and the diffusion process repeated to form the active areas (transistor emitter regions) using silicon having the same impurity concentration as the original wafer. Metal contact areas are next deposited and alloyed on the surface of the wafer. These contacts form $P\text{-}P^+$ or $n\text{-}n^+$ junctions which have very low resistance and are non-rectifying. The silicon wafer next is etched toform the mesa areas and to shape it into the required geometry (determined by the current paths). The unit is now ready for the final processing steps.

The final processing steps include lead attachment by thermal-compression-bonding, plating the leads with gold for better conductivity and hemetrically sealing the unit in a ceramic case.

The fabrication process is normally performed on a semiconductor wafer that is large enough to allow simultaneous processing of ten to twenty individual networks. A fabrication flow chart used by the Texas Instrument Company is shown in Figure 2. This chart, in essence, summarizes the complete fabrication process.

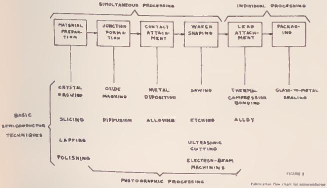


FIGURE 2

Fabrication flow chart for semiconductor networks

DESIGN LIMITATIONS

There are at present certain design limitations that must be considered before a general network can be reduced to a microelectronic functional block. Factors such as material resistivity and size limit the maximum value for bulk silicon resistors to about 40K ohms. There is no absolute limit to resistors produced by diffusion techniques. It must be remembered for p-n junction capacitors that the width of the depletion region serving as the dielectric is a function of the applied voltage and that this results in a non-linear response. Values of up to 200,000 pf per sq. cm. have been obtained using this technique. Capacitors made up of the base wafer and a metal plate deposited on a layer of silicon oxide have been produced with values up to 50,000 pf per sq. cm. Their response is linear. Size again limits the maximum component values to about 5,000 pf for the junction type and 1,000 pf for the oxide type capacitors.

The problem of producing microelectronic networks with the characteristic of inductance is in general circumvented by applying this technology only to circuits not requiring inductive reactance. Some progress though is being made in simulating inductive reactance using active networks. Also small spirals of semiconductor material can be used to realize an inductor but only for limited low values of inductance.

T.I. NOR CIRCUIT

Let us now look into the development of a particular microelectronic functional block. The circuit shown in Figure 3a is a NOR logic circuit developed by Texas Instruments, Inc.

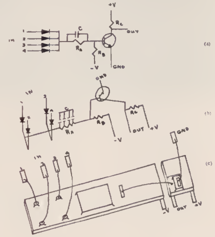


FIGURE 3

NOR Logic Circuit

The conventional schematic is transposed into the three dimensional schematic of figure 3b to illustrate the respective positions of the circuit elements within the semiconductor material. Note in particular the distributed parameter capacitor placed above the input resistor R_A. A p-n junction capacitor is particularly suited for this and it will not deter from the circuit performance.

The circuit is made up of nine components all of which are within design limitations. This circuit naturally lends itself to the microelectronic design. The resistors R_A, R_B, and R_C have values of 4, 10, and 2 kilohms and require areas of 10 X 20 mils, 10 X 50 mils, and 10 X 10 mils respectively when fabricated on a 2 mil 10 ohm-cm silicon crystal.

The transistor is a NPN type so it is necessary to fabricate the circuit on an n-type crystal. This crystal will form all the resistors, the

—Continued on page 22

Through These Portals

by Paul Travesky, EE '62

Students enrolled in the Engineering Curriculum are losing two irreplocable professors this semester. One, an instructor in Electricol Engineering ot the University since 1941, will remain on the teoching staff but will devote his attention entirely to the Metrology Progrom. The other, also o member of the Electrical Engineering Deportment, is leoving the teoching profession to take o place in private industry.

After 19 years on the campus of the George Washington University, Dr. Forest K. Harris is taking his electrical measurements course, now under the new Metrology Program, to another campus — that of the National Bureau of Standards. The students who follow him there will find one of the finest electrical measurements laboratories available for their studies. The new Metrology curriculum, within the Center for Measurement Science, was formulated by the University to meet the need for qualified persons competent in measurement science. It was natural that Dr. Harris, a leader in the measurements field, was chosen to play a leading role.

During the years that Dr. Harris taught at G.W., he missed only one semester. That was a few years back when he was selected by the National Bureau of Standards to visit other National Laboratories throughout the world. In his absence, Mrs. Bernadine Dunfee alternated with Mr. Francis Hermach in instructing his class. It is interesting to note that they were both former students of Dr. Harris, and are now members of the staff at NBS. Today Mrs. Dunfee heads a research project concerned with the measurement of a.c. current ratios and phase angles at audio frequencies, and Mr. Hermach is an authority on electro-thermal transfer instruments. What greater tribute could be given to the quality of Dr. Harris's teaching?

Unlike most professors, Dr. Harris used no textbook during his first years at the University. His lectures were given from a series of notes he prepared for class presentation. Year by year this collection of notes grew, and in 1952 they were correlated into what is now his book on Electrical Measurements, familiar to many Electrical Engineering Students. Today, this book is used not only in educational institutions, but wherever problems of measurements occur.

Dr. Harris is an alumnus of Oklahoma and Johns Hopkins Universities, and has been a physicist with the National Bureau of Standards during his entire professional career. In 1955, he received the Department of Commerce Meritorious Service Award for superior accomplishments and authorship in the field of electrical measurements. His work has been principally concerned with the development of standards and methods of precise measurements in the d.c. and low frequency fields. He is a member of the Washington Academy of Sciences, Phi Beta Kappa, Sigma Tau, Sigma Xi, and is a fellow in the A.I.E.E.

At the present time, Dr. Harris is engaged in the design and construction of a long period galvanometer for use in seismographic work and is developing a method to measure ratio and phase angle errors of instrument transformers in the 350 KV range to an accuracy of one or two thousandths of a percent.

These are just a few of the many special projects Dr. Harris manages to fit into a busy schedule at the Bureau.

There is not however, just a serious side to the Doctor. His skill as a chef is known and appreciated by his close friends. His gardening achievements are a testimonial to his manner of handling each project in a precise manner, and while he likes to relax with music of a serious vein, he can also lose himself in Perry Mason who-dun-its.

An Oriental philosopher once said: "You give but little when you give of your possessions. It is when you give of yourself that you truly give."

In the 19 years that we have known him, Dr. Harris has certainly followed this philosophy.

A well known Professor in the Electrical Engineering Department at G.W. has announced his plans to withdraw from the University's teaching staff at the end of this semester. His many accomplishments and outstanding personal qualities make it easy to give this departing member of the staff, Llewellyn A. Rubin, an appropriate farewell.

Professor Rubin received his bachelor's and master's degrees in Electrical Engineering at the Moore School of Electrical Engineering of the University of Pennsylvania where he was active in many phases of campus life. He was a member of Eta Kappa Nu, Tau Beta Pi, the campus radio station, and the student chapter of the IRE-AIEE, among others. In each instance, he served in some official capacity.

He was the recipient of a Spangler Engineering Honor Scholarship for two years and, as so many of us, worked part-time and took advantage of G.I. benefits to finance his education. Unlike many of us, he graduated "with distinction," while amassing invaluable experience in the engineering field.

This experience, included being chosen as undergraduate assistant to the eminent Dr. Ernest Frank; work at the Analytical & Computer Laboratory of the Naval Air Development Center, Johnsville, Pennsylvania, and service as a consultant with Jansky and Bailey.

A complete list of his activities and duties at George Washington would fill this magazine. In addition to a regular teaching load of 4 or 5 courses in Electrical Engineering subjects, Mr. Rubin also has supervised the Electronic and power labs; supervised installation of the school's digital computer, FLAC-II; supervised about ten undergraduate students per year in minor research projects, and was given permission to implement two new courses in laboratory projects for advanced undergraduates (EE125 and EE126). Whenever time permitted, he conducted an unsponsored research program in musical acoustics over the past five years.

Under Mr. Rubin, the laboratories at G.W. have been modernized and expanded. In addition to the FLAC-II, a small analog computer was built and is extensively used. A medium-scale relay-digital computer, which was obtained from the U. S. Navy, was repaired and installed in the E.E. Labs. This is still the only such computer in use exclusively for educational purposes in the country.

In recognition of his teaching and supervisory abilities, he represented the University at the Second Sagamore Conference on Electrical Engineering Education held at Syracuse University. He was selected to serve on the National Science Foundation Panel for the evaluation of proposals in the Laboratory Equipment Program, and was one of thirty participants in the First Annual Summer Institute on Effective Teaching for Young Engineering Teachers at Pennsylvania State University.

In addition to maintaining his association with the previously mentioned fraternities, Professor Rubin is an Associate Member of the Acoustical Society of America, the American Institute of Physics, the Washington Philosophical Society, American Society for Engineering Education and The Society of Sigma Xi.

Mr. Rubin's hobbies reflect his serious nature even while at "play." An amateur radio enthusiast who has been licensed since 1948, he is a member of the advanced class, W3MQU, K4QQB. He has designed and constructed hi-fidelity equipment and has built, and is modifying, an electronic organ.

Whether Professor Rubin is lured back into the field in which he is especially proficient, or whether he finds his niche in research and development, he leaves Tompkins Hall the richer for his having been here.

ASME

MECH MISS

Victoria Young

"Vicky" is a pretty, 19 year old junior majoring in English Literature. She was selected through a rather ingenious competitive system developed by the ASME. The "mech's" sent invitations to several sororities to submit candidates for Mech Miss. Chi Omega, without hesitation, selected Miss Young and likewise did the ASME.

Vicky comes to us from Chicago, Ill., where she completed her freshman year at Northwestern University. She has many outdoor and sports interests including horseback riding, sailing, swimming, and traveling. After school Vicky would like to write for a magazine or newspaper. She was a 1960 candidate for Illinois Cherry Blossom Princess. Among her many other attributes, Vicky has maintained a disgustingly high quality point index.

CAMPUS NEWS

The Engineer's Council held a meeting on May 3 to elect officers for the coming year. The new officers are: Floyd Mathews, President and Theta Tau representative; Dick Singer, Vice-President; Harvey Flatt, Secretary and IRE representative; Larry Hice, Treasurer and MECHELECIV Business Manager; Don Miller, Assistant Treasurer; Ray Lupo, Student Council representative; Joe Sanford and John Wolfgang, Senior Representative; Lee Kaminetzky, Junior Representative; Raghu Chari, Sophmore Representative; Deane Parker, AIEE; Fred Hood, ASCE; Dan Mulville, ASME; Doug Jones, Davis-Hodgkins House; Randy Kenyon, Sigma Tau. The MECHELECIV extends congratulations to Herb Wilkenson, the past president of the Engineer's Council, and to the members of his staff for a job well done.

The Engineer's Ball was a roaring success, discounting the lack of participation by the student body. Those who attended found it well worth their time and money. The following awards were presented at the dance. The Engineer's Alumni Association Award to Outstanding Seniors. Recipients of these awards are: Dave Trask, ME; Paul Rova, CE; Bob Boardway, BSE; Herb Wilkenson, EE. Also presented were the Engineer's Council Keys, MECHELECIV Keys, Deacon Ames Award, Sigma Tau Award, and the Sigma Epsilon Award.

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AUTHORS INTRODUCTION

John Locke was a British philosopher interested in epistemology, the theory of knowledge. His theory of knowledge contained the major premise that man knew not the real world but only that which was perceived through a screen surrounding his mind. This screens texture was made up of man's ideas, images, and impressions. To Mr. Locke, the substratum of the real world was quite remote and he called it "that substance I know not what." Man, he believed, perceived only his own ideas. Many men called this train of thought a form of barren skepticism, arguing, a chair is a chair and a mountain is probably a very good facsimile of a mountain. To this argument Bertrand Russell added, "Only philosophers with a long training in absurdity could have succeeded in believing otherwise."

Even now, 300 years later, it's still possible to get a chuckle out of poor old Mr. Locke's philosophy. But those engineers who speak of such things as electrons and related subjects had better not chuckle too loudly. For, what is an electron? Is it a charged particle orbiting around a nucleus? Or is it a condition of space surrounding a nucleus? Field Theory affords many more examples of objects of knowledge that are used with facility in physical explanations of the world but must, in final analysis, be classified as "that substance I know not what". Perhaps it is time to reread Mr. Locke.

Locke's Lament

Brooks do not babble
Chatter nor speak
They can't be compar'd
To our ways so weak

They have their substance
And we have our mind
They make brook noises
We hear but our kind

Man thinks of nature
With man's six senses
Thus hiding nature
With six high fences

Yet simply we say
Nature is known
Not ever knowing
Our world's mind-grown

J.E.B.

other ferrous alloys are satisfactory. The bonding surface should be free from grease and moisture. If loose scale and dirt are present, they should be removed by sand-blasting or any other acceptable method. If there is no loose or scaly oxide layer, degreasing in a toluene wash, followed by acetone rinse is an excellent and rapid cleaning technique.

The SE-5504U compound is applied to the metal surface under pressure. This assures intimate contact of the compound with the surface and forces out entrapped air and volatiles which may degrade the rubber structure and bonding ability. Depending upon the geometry of the system and the catalyst used, cure time and temperature will vary. Recommendations for general applications are as follows: Press cure the stock for 15 to 30 minutes at 270-300F using Benzoyl Peroxide Powder and 15 to 30 minutes at 330-350F using Varox or Dicumyl Peroxide.

To optimize the best rubber to metal bond, one of the following post-cure cycles may be used: 8 hr/300F, 16 hr/300F, 4 hr/350F or 4 hr/400F. As is the case with most other silicone rubber compounds, program curing can be successfully used when thick section (greater than 1/4 inch) parts must be obtained.

SE-5504U can be used with primer for non-ferrous metals to establish excellent bonds as in the instance of aluminum and aluminum alloys. The addition of process aids cause a reduction in bonding quality. Beyond those process aids already contained in the compounds, it is not recommended that further process aid be incorporated. It also should be noted that aluminum and aluminum alloys do not give bonds of a quality comparable to iron-containing alloys.

TYPICAL SCENE FROM

GWU ENGINEERING PARKING LOT


POLARIS
U.S. NAVY

TECH NEWS

Edited by Moffette Tharpe

The National Bureau of Standards recently acquired a 50,000-curie cobalt 60 source for use in a variety of research programs. This source, which produces as much gamma radiation as 180 pounds of radium, has increased the Bureau's present irradiation capacity by a factor of about 25.

In recent years, cobalt 60 has been increasingly used for radiographic, therapeutic, and instrument calibration purposes, and for radiation mechanism studies. The new 50,000-curie radiation source will greatly extend the Bureau's capabilities in gamma-ray research and it will be a valuable tool for studying the properties of materials in their interactions with radiation.

The cobalt 60 was produced from pellets of nonradioactive cobalt 59 by neutron bombardment in the reactor. After irradiation, the activity of each pellet was determined, and then 75 pellets were loaded into each of 12 cylindrical stainless steel capsules. The pellets were selected and placed with those of greatest activity at the ends of the capsules, so as to produce a more uniform field. Care was also taken to load each capsule to near-equal total activity. After loading, metal plugs were welded into the opening of each capsule to seal them against leakage.

A five-ton lead container, mounted on a specially fitted truck, was used to transport the capsules from Oak Ridge to Washington, D. C. Water was circulated over the capsules to dissipate the heat generated by the radiation. At the Bureau, the capsules were removed from their lead container and inserted in holes drilled in a steel plate. Thus the capsules, standing vertically, form an open circle. The unloading, and subsequent storage of the capsules, was accomplished under about 11 feet of water.

The source will be used in a number of investigations. The effects of intense gamma radiation on various fluorocarbons, both at normal and high pressure, will be studied, as will be gamma-ray production of radicals at low temperature. The source will also be used in a program investigating the relation between radiolysis and photolysis. Various gases will be exposed to the source, then analyzed with a mass spectrograph to determine what products resulted from irradiation. In all cases, the intense activity of the source will result in greatly reduced exposure times, and thus accelerate the research programs involved.

KODACHROME II FILM LEADS NEW PRODUCT PARADE

Heading the list of products introduced during the first few months of 1961 is Kodachrome II Film. This film represents the most significant of the many advancements in Kodachrome since its introduction over 25 years ago.

Kodachrome II is 2-1/2 times as fast as regular Kodachrome Film . . . it has increased sharpness and improved color rendition. The faster speed will permit picturetaking under less favorable lighting conditions.

The improved film is capable of recording sharper pictures with even less graininess than regular Kodachrome Film. This sharpness is most evident in 8mm movies, where projection magnification is greatest.

Due to changes in manufacturing, supplies of the film will be limited for some time. A modification of the developing process also is required for handling Kodachrome II Film. All U.S. Kodak laboratories are now equipped for processing the improved film. Other laboratories have been advised of necessary changes and some are already equipped to handle it.

One of the world's most powerful neutron physics research tools was previewed here today at a symposium held at Rensselaer Polytechnic Institute. The machine is a microwave linear accelerator, called a "Linac", which will produce intense bursts of neutrons needed for studies aimed at improving the efficiency of atomic power reactors as well as basic physics research.

RPI scientists will use the machine to measure the energy of neutrons in flight to study fundamental nuclear reactor physics. Knowledge of the exact behavior of neutrons and their interactions with other materials is one of the keys to improved atomic power reactors. RPI will also use the Linac for solid state physics research and for studies of the effects of radiation on materials.

Pulsed electrons have a maximum energy of 77-million-electron volts (Mev) in the acceleration waveguide of the 25-foot-long Linac, and the intense flux of neutrons needed by researchers to study atomic phenomena is produced when these electrons hit a target of suitable materials. The machine will generate one of the highest neutron fluxes ever produced by an accelerator—about 10^{14} fast neutrons per second or a thermal neutron flux of 10^{12} neutrons/second/centimeter^2.

North American Aviation, Inc., recently announced its Rocketdyne division has designed and will build and operate a pilot plant to convert sea water to fresh water.

The pilot plant will be built at an ocean site near Oxnard, Calif., on several acres of land leased from Southern California Edison Co., said Rocketdyne President S. K. Hoffman. Construction will start this month and the plant is scheduled to go on stream this fall.

The pilot plant will produce from 15,000 to 20,000 gallons of fresh water daily.

The process is based on concepts originated some years ago by Drs. Ludwig Rosenstein and Manuel Gorin, chemical consultants, of San Francisco. It eliminates conventional heat exchangers in all major sections.

The process includes four main steps: precooling, freezing, washing and melting. In precooling, the sea water temperature is lowered to near freezing by passing a hydrocarbon liquid compound such as octane directly through it, the octane as a liquid having been previously cooled by various process streams.

A more volatile hydrocarbon compound such as butane is used in the second step to freeze

—Continued on page 20

the water. The butane also enters as a liquid and absorbs heat to become a gas. In this step ice crystals of fresh water are formed.

The crystals are coated with brine, which is washed off in the third step.

The ice crystals then are melted into fresh water in the fourth step by direct contact with compressed butane.

The system is self-contained and the hydrocarbon compounds are recycled continuously so that no hydrocarbons are carried out with the product water.

The fresh cold water produced and other process streams are used to cool the hydrocarbon compounds before they enter the tanks of sea water.

PORTABLE He^3 REFRIGERATOR

A continuously operation He^3 refrigerator, capable of maintaining temperatures as low as 0.26°K, has been developed by the National Bureau of Standards. This apparatus will be used for a variety of experiments, including magnetic and thermal measurements on paramagnetic substances, and nuclear orientation studies. The apparatus extends the region of convenient and continuous refrigeration down from about 1°K, reached simply by using He^4, into the range previously accessible only by using the process of magnetic cooling. Although the refrigerator is not the first of its general type, it is particularly efficient and effective, and possesses many novel features which permit simple construction and operation.

The rarity and high cost of He^3 requires tha it be conserved, rather than being boiled off int the atmosphere as is He^4. As the present refrigerator uses a circulation system, similar in some ways to that used in a conventional household refrigerator, only a small amount of He^3 is needed, and at the same time refrigeration can be obtained for as long as is desired.

To circulate the He^3, the NBS refrigerator uses a mercury ejector pump (without a mechanical backing pump) operating at a discharge pressure of about 35 mm Hg. He^3 gas returning from the pumps is reliquefied in a condenser maintained at 0.8°K by means of a pumped He^4 bath.

The condenser, evaporator, and effective working space of the refrigerator are enclosed in a vacuum case and surrounded by a Dewar of He^4, which in turn is surrounded by a Dewar of nitrogen. Two cm^3 of liquid He^3 are used in this system. The He^3 is cleaned on each cycle by passing through liquid nitrogen cooled traps on either side of the mercury pump, and by a small trap filled with copper wire in the He^4 Dewar. The fact that no mechanical pumps are used allows a compact, fast, quiet, self-regulating system to be constructed.

The lowest temperature reached with this refrigerator is 0.26°K at zero heat input. The maximum refrigeration capacity is 2 mW, at which load the temperature can be maintained at 0.40°K. These temperatures are achieved in a working volume of about 500 cm^3.

cathode of each diode and the transistor collector region. An oxide mask is placed on the crystal and then selectively removed to expose the diffusion areas. A p-type impurity is diffused into the base crystal to form the diode anodes, the transistor base region and the capacitor. Next a layer of n-type material is diffused to form the transistor emitter region.

The contacts are deposited and alloyed on the crystal, the mesa areas are etched and the crystal is then separated into two pieces. It is necessary to separate the crystal in order to isolate the transistor collector region from the base circuit. The input, output and jumper leads are now bonded to the wafer and it is hemetrically sealed in a ceramic case.

A pictorial schematic of the network is shown in figure 3a illustrating the semiconductor structure before it is encased. The final hemetrically sealed package weighs 0.05 grams and has dimensions of 0.250 X 0.225 X 0.030 inches including the leads. After fabrication only one set of tests are necessary for the whole network.

OTHER DEVELOPMENTS

Texas Instruments, Inc. using the trade name SOLID CIRCUIT now has on the market a commercially available bistable multivibrator. The equivalent circuit for this unit contains 2 transistors, 4 diodes, 4 capacitors and 6 resistors.

The Westinghouse Corporation, adopting the term "molecular electronics" has developed eighteen different types of functional blocks. Their approach is similar to that of Texas Instruments' but they have incorporated one additional criterion. This is that there will be no internal wire connections. This criterion should increase the reliability of their microelectronic functional blocks by further reducing the number of connections in the device. Several examples of Westinghouse developments follow.

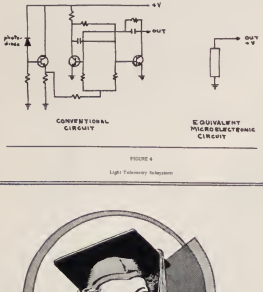

FIGURE 4

Light Telemetry Subsystem

A light telemetry subsystem consisting of a single, light responsive, monolithic element which delivers an output whose frequency is a measure of light intensity is shown in Figure 4 along with its equivalent circuit. The unit requires only two external connections. Figure 5 shows several other Westinghouse developments. They are (left to right) a 3-watt audio amplifier, a free-running multivibrator and a two-stage video amplifier which operates at 3 mc.

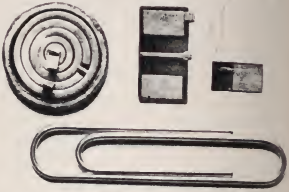

FIGURE 5

Westinghouse Developments

IN CLOSING

We have seen several of the approaches presently under development in an effort to realize microelectronic functional blocks. These approaches have been fruitful but they by no means exhaust the realm of possibilities. I feel that as new semiconductor materials and new techniques are developed the present limitations on microelectronic circuits will fall by the wayside and open up broad horizons of electronic development.

EDITORS NOTE

I would like to thank Miss Jeanne Kandsberger of the Westinghouse College Editorial Service and Robert Potterfield of Texas Instruments Customer Relations Department for their help in supplying material for this report.

Two English gentlemen were standing together, waiting for some one to come from the powder room. A moment later, two women walked out.

"There's an odd one," murmured the first, "here comes my wife with my mistress."

"Jove," exclaimed the second, "you took the words right out of my mouth."

A little man was strolling down the street leading his little yellow dog when suddenly he encountered a big guy with a huge bulldog. "Keep your dog away from my dog," shouted the little man. "I warn you!"

The big guy snorted and said: "That's a laugh. What could a little yellow dog like that do to my big bulldog?"

And bang! The fight started. Just when it looked as if the big bulldog would chew up the little yellow dog, the little dog opened its mouth and whammo! . . .That was the end of the big bulldog.

Well, naturally, the big guy was flabbergasted and he screamed at the little fellow: "Say, what kind of a dog do you call that?"

"Well," said the little man, "Before I cut off his tail and painted him yellow, he was an alligator."

Wife to Husband, driving home: "Well, you certainly made a fool of yourself. I can only hope that no one at the party realized that you were sober."

I think that I shall never see.
A girl refuse a meal that's free;
A girl with hungry eyes not fixed
Upon a drink that's being mixed;
A girl who doesn't like to wear
A lot of junk to match her hair!
But are loved by guys like me
'Cause darn if I will kiss a tree.

After five years of duty a sailor was discharged from the service. Upon returning home he made a beeline for his old civilian clothes. He tried on one of his suits and in the left-hand pocket found a ticket from a Chinese laundry. The ticket was yellow with age. Wondering if the laundry was still at the printed address, the ex-gob went to the store and presented the ticket to a Chinaman.

"One moment, please," said the Chinaman. He retreated to the rear of the store. Two minutes later he re-appeared, still holding the laundry ticket. "So sorry," he smiled. "Be ready next Thursday."

"Do you like dancing?"
"Yes, I love to!"
"Good, that's even better than dancing!"

"Is this a picture of your fiancee?"
"Yes."
"She must be wealthy."

Origin of the Charleston: When a Scotsman tried to pick the lock on a pay toilet.

Boy: "I'm not feeling myself tonight."

Girl: "You're telling me!"

Little Jackie entered first grade, where his teacher was a very well-proportioned young lady who enjoyed very loose-fitting blouses. One evening, several hours after school was over, she was having dinner in a restaurant when Jackie and his parents came in.

"Daddy," the kid yelled, and all the diners turned toward him, "There's Miss Smith. You shoulda been in school today. She leaned over too far, and one of her lungs fell out."

Nobody gave the bride away, but several young men at the wedding could have if they had decided to talk.

MY TRUE CONFESSION

"I had," said Mr. X, "twelve bottles of whiskey in my cellar and my wife made me empty the contents of each and every bottle down the sink. I proceeded to do so as she desired and withdrew the cork from the first bottle poured the contents down the sink with the exception of one glass, which I drank.

"I then withdrew the cork from the second bottle and did likewise with the exception of the one glass which I drank.

"I extracted the cork from the third bottle and emptied the good old booze down the sink, except a glass which I devoured.

"I pulled the cork from the fourth sink and poured the bottle down the glass which I drank.

"I pulled the bottle from the next cork and poured the bottle down my neck.

"I pulled the next cork from my throat and poured the sink down the bottle and drank the cork.

"Then I corked the sink with the glass, bottled the drink and drank the pour.

"Well, I had them all emptied and I steadied the house with one hand and counted the bottles which were 24. So I counted them again when they came round and I had 74. And as the house came round again I counted them and finally I had all the houses and bottles counted except one house and one bottle which I drank."

One of a series

Interview with General Electric's

Francis J. Boucher

Manager-Manufacturing Personnel Development Service

How Good Is Your Best Job Offer . . .

Q. Mr. Boucher, with all the job interviews a graduating engineer goes through, how can he be reasonably sure he has made the right choice?

A. This is a good question because few seniors have enough work experience in industry, government and educational institutions to allow them to make a fully reasoned choice. However, I think the first step is to be sure that short-term factors like starting salary and location don't outweigh long-range factors like opportunity and professional growth. All of these factors should be evaluated *before making a final commitment.*

Q. But you do feel that starting salary is important?

A. Very much so. If you are married—it may be an even greater consideration. But you should also look beyond starting salary. Find out, for example, if the company you are considering has a good salary administration plan. If there is no way of *formally* appraising your performance and determining your appropriate rewards, you run the risk of becoming dissatisfied or stalemated due to neglect of these important considerations.

Q. What considerations do you feel should be evaluated in reaching a job decision?

A. Let me refer you to a paper written by Dr. L. E. Saline, now Manager of Information Systems in our Defense Systems Department. It is titled "How to Evaluate Job Offers." (Incidentally, you may obtain a copy by writing as directed in the last paragraph.) In it, Dr. Saline proposes six questions—the answers to which should give you much of the information you'll need for an objective job-offer evaluation. He suggests you determine . . .

- to what degree will the work be challenging and satisfying?
- what opportunities are available to further develop abilities?
- what opportunities are there for advancing in the Company (and how dynamic the Company is in the marketplace is an important aspect of this question).
- what salary potentials are possible with respect to the future?
- what about geographical location —now and in the future?
- what effort does the Company make to establish and maintain a professional climate?

There is more to these questions than meets the eye and I think you would enjoy reading Dr. Saline's paper.

Q. What about the openings on defense projects that are listed in the various magazines and newspapers?

A. Presumably, there will always be a need for technical manpower in the defense business. But I want to point out to you that most of these opportunities are for experienced personnel, or personnel with specific additional training received at the graduate level.

Q. How do you feel about training programs? Do they offer any particular advantages over any other offer I might accept?

A. I feel training programs are particularly helpful in easing the transition from an academic to a business environment. Of course they provide formal training designed to add to the individual's basic fund of knowledge. They also provide working experience in a variety of fields and a broad knowledge of the company concerned and its scope of operations. Upon completion, the individual is generally better prepared to decide the direction in which he will pursue his professional career.

General Electric conducts a number of training programs. Those that attract the greatest number of engineers are the Engineering and Science, Manufacturing, and Technical Marketing Programs. Each combines a formal, graduate-level study curriculum, on-the-job experience, and rotating assignments. There is little question in my mind that when an engineer completes the Program of his choice, he is far better prepared to choose his field by interest and by capability. I might also add that because of this, he is more valuable to the Company as an employee.

Q. Then you feel that a training program is the best alternative for a graduating engineer?

A. Not always. Some seniors have already determined the specific field they are best suited for in terms of their own interests and capabilities. In such cases, direct placement into this specific field may be more advantageous. Professional self-development for these employees, as for all General Electric technical employees, is encouraged through a variety of programs including the Company's Tuition Refund Program for work toward advanced degrees, in-plant courses conducted at the graduate level, and others designed to meet individual needs.

Q. For the record, how would you rate a job offer from General Electric?

A. I've tried to get across the need for factual information and a long-range outlook as the keys to any good job evaluation. With respect to the General Electric Company, seniors and placement offices have access to a wide variety of information about the Company, its professional environment and its personnel practices. I think qualified seniors will also discover that General Electric offers professional opportunity second to none—and starting salaries that are competitive with the average offered throughout industry today. From the above, you can see that I would rate a job offer from General Electric very highly.

Want more information about General Electric's training programs? You can get it, together with a copy of Dr. Saline's paper "How to Evaluate Job Offers" by writing to "Personalized Career Planning," General Electric Company, Section 959-15, Schenectady 5, New York.

GENERAL ELECTRIC